

**APPLICATION
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**TITLE: METHOD, APPARATUS, AND SYSTEM FOR VIDEO
FAST FORWARD FUNCTIONALITY IN A MOBILE PHONE**

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**METHOD, APPARATUS, AND SYSTEM FOR VIDEO
FAST FORWARD FUNCTIONALITY IN A MOBILE PHONE**

FIELD OF THE INVENTION

The present invention relates to the field of motion video playback systems. More specifically, the present invention relates to fast forward functionality of motion video playback in wireless phone systems.

BACKGROUND OF THE INVENTION

Digital motion video playback systems have undergone much improvement in recent years. As microchip processors have become faster and data storage mediums have increased data storage capacities, digital motion video playback has become an increasingly viable option for smaller devices operating with limited resources. For instance, handheld digital video disc (DVD) players permit the user to view a feature film on a small liquid crystal display (LCD) attached to the player. Inherent in efficient digital motion video storage and transmission are data compression and encoding techniques which permit preferred balancing of playback quality, data file size, and available bandwidth. Among the primary motion video compression standards are H.261, H.263, and those established by the Moving Pictures Experts Group (MPEG), including MPEG-1, MPEG-2, and MPEG-4, which provide for increasing playback quality in exchange for higher bit rates requiring larger bandwidths for transmission.

Issues regarding bandwidth requirements become magnified when data rich applications are implemented in a wireless transmission context. Wireless phone service providers are always mindful of the limited bandwidths available for their use while attempting to maximize capacity on their cellular networks. The progression of cellular network technology from analog signals to digital signals significantly increased the subscriber capacities as well as possible capabilities of wireless cellular networks, but improvements have been incremental since the advent of digital service. By varying the transmission format, e.g., time division multiple access (TDMA) versus code division multiple access (CDMA), and the wireless communication standard, e.g. GSM, TETRA, and UMTS, varying levels of network performance can be achieved. Though, the limited bandwidth of a wireless phone system still poses serious problems for the transmission of the huge volumes of data required to display high quality motion video. Sophisticated compression procedures present partial solutions. Formatting the video for smaller screens helps also. Efforts are underway to further fine-tune a feasible solution.

One aspect of motion video playback on a wireless phone that raises special difficulties is dealing with skipping back or ahead in the video during playback. For instance, if a user wishes to view a clip of a video halfway into the video, the user would prefer to skip ahead to the desired clip than to view the entire length of the video preceding the clip. When the video display device has the data storage capacity to store the entire motion video, such as with the handheld DVD player, skipping between clips spread out across the duration of the motion video can be done readily by accessing the associated data directly. However, in the context of a wireless phone, little more than a short duration of the motion video will likely be buffered in the phone memory, so skipping between clips must be done remotely from the source of the motion video.

SUMMARY OF THE INVENTION

This present invention includes a method and an apparatus for receiving motion video as well as the software necessary to implement the method and to program the apparatus. The method includes receiving motion video data at a wireless terminal from a motion video server via a wireless interface, displaying the motion video on a video display on the wireless terminal, and transmitting to the motion video server via the wireless interface display control commands to alter the presentation characteristics of received motion video. The motion video is received having fixed presentation characteristics, according to which the motion video images are presented on the display. By transmitting the display control commands to the motion video server via the wireless interface, the wireless terminal may remotely alter the presentation characteristics of the received motion video, and hence may alter the way in which the motion video is presented on the display. The invention may be embodied in an apparatus such as a wireless telephone.

The user of the wireless terminal may alter the presentation characteristics so as, among other options, to increase or decrease the speed of the motion depicted in the video presentation, reverse the direction of the depicted motion, or both. In particular, if the display control command instructs the motion video server to increase the speed of the motion depicted in the video presentation, the motion video server may filter out any audio data and sample the video data comprising the motion video to reduce the number of video image frames transmitted to the wireless terminal. The user may repeatedly input a new display control command to alter the presentation characteristics of the motion video, such as to reset them to the standard playback

presentation characteristics of the motion video which would re-synchronize the audio data with the video data.

The present invention also includes a method and a system for transmitting motion video, as well as the software necessary to implement the method and program the system. The method includes receiving motion video data from a motion video server, transmitting the motion video data to a wireless terminal via a wireless interface, receiving from the wireless terminal via the wireless interface display control commands to alter the presentation characteristics of motion video, and transmitting the display control commands to the motion video server. The invention may be implemented, for example, using a digital wireless telephony network which may include multiple cellular base stations.

The details of one or more embodiments of the inventions are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram of a wireless system for a variable playback of a motion video;

FIG. 2 is a block diagram of a data stream during normal playback;

FIG. 3 is a block diagram of a data stream having very fast motion presentation characteristics;

FIG. 4 is a block diagram of a data stream having fast motion presentation characteristics; and,

FIG. 5 is a block diagram of a wireless terminal.

FIG. 6 is a block diagram of a method to transmit via a wireless interface system a motion video having Fast Forward presentation characteristics.

FIG. 7 is a block diagram of a method to display on a wireless terminal a motion video received having Fast Forward presentation characteristics.

DETAILED DESCRIPTION

FIG. 1 shows a system 200 for receiving motion video data streams 210 transmitted from a motion video server 220 to a wireless terminal 100 over a wireless interface 230 and displaying the motion video to a terminal user. Implementations of the system 200 may include a display control command input device 130 allowing the user to send video display control commands 160 from the terminal 100 to the video server 220. The video display control commands 160 can be used to alter the presentation characteristics of the motion video, e.g. to change the speed of the motion video, to reverse the video, to stop and/or pause the video, and to make other changes to the presentation characteristics of the video.

Motion video can be transmitted from the video server 220 to the terminal 100 in a digitally compressed and encoded form, such as MPEG-2. Digitally compressed and encoded motion video is typically composed of a series of video image frames 240 which are presented in rapid succession to the user to give the appearance of motion. For example, a television set may present thirty video frames per second to form a motion picture. Digitally compressed and encoded motion video frames 240 may include Intra-frames 241 and Inter-frames 242. In general, an Intra-frame 241 includes full picture information needed to render the frame to a display 120, while an Inter-frame 242 includes picture information that depends on one or more Intra-frames 241. For example, an Inter-frame 242 may form an image using received data that identifies incremental changes to a previous frame. Using Inter-frames 240 and Intra-frames 241 may help reduce the bit rate of a transmitted full motion video image.

After the user activates video receiving functions on the terminal 100, the terminal 100 establishes a connection with a motion video server 220 over a wireless interface 230. The terminal 100 may receive information over the wireless interface 230 from the motion video server 220 identifying motion videos available for viewing. The user of the terminal 100 may then select a motion video to display. The user may also select presentation characteristics of the video. For example, the user may select a fast-forward presentation. The user inputs the selection on a display control command input device 130 on the terminal 100. The terminal 100 transmits this selection information to the motion video server 220 over the wireless interface 230. The motion video server 220 may package the selected motion video as a data stream 210 of compressed, encoded video images. The wireless interface 230 transmits the data stream 210 to the wireless terminal 100, which receives and processes the data stream 210. The terminal

100 may decompress and decode the video images to display the motion video on a video display 120 on the terminal 100. The video display 120 will display the video images according to presentation characteristics inherent in the motion video. For instance, when the video server 220 transmits a motion video in fast forward, the video display 120 will present the video in fast forward.

The user may select different presentation characteristics of the received motion video by inputting a new display control command 160 on the display control command input device 130. The terminal 100 transmits the display control command 160 to alter the presentation characteristics of the motion video over the wireless interface 230. The motion video server 220 receives and responds to the display control command 160 by adjusting the way in which the motion video server 220 packages the compressed, encoded video images within the data stream 210. The motion video server 220 transmits the motion video with the altered presentation characteristics as a subsequent data stream 212. The terminal 100 receives and processes the subsequent data stream 212. The video display 120 decompresses, decodes and displays the sequence of video images contained in the subsequent data stream 212. The motion video displayed using the subsequent data stream 212 has the altered presentation characteristics specified by the display control command 160 selected by the user.

Multiple implementations are possible given the variety of ways in which the elements may be combined. For instance, the wireless interface 230 may be wireless digital communication network 231 having multiple base stations 232 spread out in a honeycomb fashion designed to accommodate a number of wireless telephone subscribers 101. The base stations 232 may have radio frequency transmitter circuitry 233 capable of transmitting the motion video data streams 210 to the wireless terminal 100 and radio frequency receiver circuitry 234 capable of receiving the display control commands 160 from the wireless terminal 100. The motion video server 220 may be present at a base station 232 or it may be connected to the wireless interface 230 via the Internet or via another off-site, network connection. The server 220 includes programming and circuitry 221 capable of processing the display control commands 160 and configuring the data streams 210 accordingly. For example, the server 220 may include an MPEG-2 video encoder 222 and a CDMA multiplexer circuitry 223. The motion video server 220 may be connected either internally or via a network connection to one or more video database storage devices 224 storing the available motion videos. The server 220 may also

have one or more high speed data processors 225 to configure multiple data streams 210, each destined for a different wireless terminal 100.

The wireless terminal 100 could be a modified cell phone 101, a modified personal data assistant (PDA) 102, or a laptop computer with a wireless modem 103. The display control
5 command input device 130 may be a keypad 131, a pointing device 132, a set of buttons 133, an on-screen cursor-based menu 134, or voice-activated circuitry 135. The input device 130 may further be a display control command-specific dedicated device 136 (as appears on a typical CD player remote control), or a multiple-function device 137 (such as a computer mouse or a dial
10 pad on a phone). The video display 120 may display either color images or monochromatic images.

The motion video comprises a sequence of video images encoded as video data. The sequence of video images is characterized by standard presentation characteristics. One presentation characteristic corresponds to the apparent speed of the relative motion depicted by the motion video. The standard apparent speed of the relative motion depicted by the motion
5 video is referred to as real-time. A motion video is displayed at a substantially real-time if the apparent speed of the relative motion approximates the standard presentation characteristics. Another presentation characteristic corresponds to the apparent time order of the motion depicted by the motion video. Displaying the motion video images in their standard time order characterizes a forward presentation, whereas displaying the motion video images in reverse time
20 order characterizes a reverse presentation.

The presentation characteristics of a motion video correspond inversely with the time-delay between the display of the video images at the start and finish of the sequence. A sequence of encoded video images typically includes time-stamp data indicating the standard display time of each image relative to the beginning of the motion video. The standard display time of each
25 image relative to the other images within the sequence is referred to as the standard time-delay between video images. Presentation characteristics corresponding to real-time occur when the motion video is displayed using the standard time-delay between video images.

When a sequence of video images is displayed in less time than the time characteristic of the standard presentation, the relative motion of the motion video appears faster. When the
30 relative motion of a motion video appears faster than the standard apparent speed of the relative motion, the presentation of the motion video is characterized by relative motion which is faster

than real-time. Conversely, when a sequence of video images is displayed in more time than the time characteristic of the standard presentation, the relative motion of the motion video appears slower. When the relative motion of the motion video appears slower than the standard apparent speed of the relative motion, the presentation of the motion video is characterized by relative motion which is slower than real-time.

In order to alter the presentation characteristics of the motion video, the motion video server 220 may adjust the sequence of the compressed, encoded video images within the data stream 210. Changes in the presentation characteristics of the motion video may or may not be accompanied by a change in the bit rate of digitized video information transmitted from the base station to the wireless terminal 100. For example, displaying a fast forwarded video for 15 seconds may require the same data rate as displaying a normal video for 15 seconds; the rates may be equalized by eliminating extraneous frames from the fast forwarded video. To accelerate the presentation and relative motion of the motion video, the sequence of video images may be filtered. By filtering the sequence of video images, fewer images are displayed to represent the motion video. Because fewer images are displayed, they may be displayed in less time, giving the appearance that the relative motion is occurring more quickly. Hence the motion video is presented faster than real-time.

FIG. 2 shows a representation of the initial data stream 211. Typical data compression methods used to compress motion video data separate the data into frames 240 known as Intra-frames 241 and Inter-frames 242. An Intra-frame 241 is an independent representation of a video image, whereas an Inter-frame 242 is a video image representation dependent on one or more Intra-frames 241. Inter-frames 242 generally are displayed in time between Intra-frames 241, and Inter-frames 242 frequently outnumber Intra-frames 241 to achieve higher data compression rates. Each frame is encoded with a data packet header describing the contents, such as whether the frame is an Intra-frame 241 or Inter-frame 242, or contains audio or video data.

One technique to alter the presentation characteristics to achieve a fast forward motion video presentation is to filter the sequence is to select a representative sampling of the sequence. A representative sampling of the sequence may be displayed in less time than the time necessary to display the entire sequence. By displaying a representative sampling of a sequence of video images instead of the entire sequence, a presentation is achieved that characterized as faster than

real-time. A representative sampling of a sequence of video images encoded as Intra-frames 241 and Inter-frames 242 may be selected by reducing the number of Inter-frames 242 within the sequence.

FIG. 3 shows a representation of a subsequent data stream 212 having altered presentation characteristics that correspond to faster than real-time relative motion. The sequence of video images has been filtered to reduce the number of Inter-frames 242 separating the Intra-frames 241. In FIG. 3, the number of Inter-frames 242 has been reduced to zero, however, it is not necessary to eliminate all Inter-frames 242 to achieve a presentation characterized by relative motion that is faster than real-time. The greater the reduction in the number of frames 240 received and displayed per sequence of video images (i.e. the more frames 242 that are filtered out), the more rapidly the sequence is displayed, and thus the faster the relative motion of the motion video. In FIG 4, the number of Inter-frames 242 has been reduced by over half. For a given sequence of video images, FIG 4 represents a motion video presentation characterized by relative motion faster than relative motion of the motion video presentation represented by FIG 2. In contrast, the relative motion of FIG. 4 is slower than the relative motion of FIG 3.

At any point during the display of the motion video having the altered presentation characteristics, the user again may select to alter the presentation characteristics of the motion video. The user inputs the display control command 160 corresponding to the intended presentation characteristics, and the display control command 160 is transmitted to the motion video server 220 over the wireless interface 230. As before, the motion video server 220 adjusts the sequence of the video image frames 240 that appears in the data stream 210 to reflect the intended presentation characteristics of the motion video to be transmitted to the wireless terminal 100.

The motion video may also include a soundtrack, compressed and encoded in audio data. The soundtrack may be synchronized with the video images. During the display of a motion video characterized by a presentation that is faster than real-time, the motion video server 220 may also filter the data frames 240 to remove the frames 243 that correspond to audio data. This also accelerates the presentation of motion video in so far as fewer frames 240 are transmitted to the wireless terminal 100. The audio frames 243 are identified as such by a stream-identification within the packet header. While the audio data frames 243 are being filtered out, the motion

video server 220 maintains synchronization of the audio data with the corresponding video data to permit full audiovisual performance of the motion video once the presentation characteristics are reset to standard real-time.

Synchronization of the audio and video is achieved by tracking the time-stamp data of the video images transmitted to the terminal 100. For each motion video available on the motion video server 220, the server 220 has a database of time-stamp information detailing the standard presentation characteristics of location and timing of each audio or video frame relative to the beginning of the given motion video. By comparing the time-stamp data of the most recently transmitted video image with the standard presentation location and timing information for that video image, the motion video server 220 determines what audio and video frames 240 are in synchronization when the presentation characteristics are reset to standard real-time. Once the user selects to display the motion video at real-time, the motion video server 220 ceases to filter the data frames 242 and 243 and sequences the frames 240 so that they are in audiovisual synchronization with one another.

FIG. 5 shows a wireless terminal 100 for receiving and displaying motion video data. The wireless terminal 100 has radio frequency receiver circuitry 110; a video display 120; a display control command input device 130; radio frequency transmitter circuitry 140; and a power supply 150, all electronically coupled. In one implementation, the wireless terminal 100 may be a digital wireless telephone 101.

The radio frequency receiver circuitry 110 receives radio signals encoding data streams 210 comprising motion video images. The receiver circuitry 110 relays the motion video data to the video display 120 to be displayed.

The video display 120 displays the received motion video. The video display 120 has display circuitry 121 to rasterize the motion video on a screen. The video display 120 may be a liquid crystal display (LCD) or other commonly known display, which may display images in monochrome or color. The video display 120 may also have audio speakers 122, coupled either internally or externally via an audio jack 123. The video display 120 may also have decompression and decoding circuitry 124 to process the data streams 210 relayed by the receiver circuitry 110. The audio speakers 122 may receive audio signals from the decompression and decoding circuitry 124 and replicate the received soundtrack in synchronization with the video images during the playback of the received motion video.

The display control command input device 130 generates the display control command 160, which alters the presentation characteristics of received motion video. The display control command input device 130 may be a keypad 131, a pointing device 132, a set of buttons 133, an on-screen cursor-based menu 134, or voice-activated circuitry 135. The input device 130 may further be a display control command-specific dedicated device 136 (as appears on a typical CD player remote control), or a multiple-function device 137 (such as a computer mouse or a dial pad on a phone). The display control commands 160 available on the input device 130 may include Stop 161, Pause 162, Slow Forward 163, Play Forward 164, Fast Forward 165, Slow Reverse 166, Play Rewind 167, and Fast Rewind 168. The display control command input device 130 may also have compression and encoding circuitry 138 to process the display control command 160 prior to relaying the display control command 160 to the transmitter circuitry 140 to be transmitted.

Display control command Stop 161 stops the display of the motion video, while Pause 162 causes the instant video image to remain displayed as a still image. Slow Forward 163 displays the motion video at a forward presentation characterized as slower than real-time; Play Forward 164 displays the motion video at a forward presentation characterized as real-time; and Fast Forward 165 displays the motion video at a forward presentation characterized as faster than real-time. Slow Reverse 166 displays the motion video at a reverse presentation characterized as slower than real-time; Play Rewind 167 displays the motion video at a reverse presentation characterized as real-time; and Fast Rewind 168 displays the motion video at a reverse presentation characterized as faster than real-time.

The radio frequency transmitter circuitry 140 transmits over a wireless interface 230 to a motion video server 220 radio signals encoding the display control command 160 relayed from the display control command input device 130.

The power supply 150 supplies electrical power to the wireless terminal 100. Any appropriate power supply may be chosen. The power supply 150 may include a long-life, rechargeable battery 151 and possibly an integrated recharging device 152.

FIG. 6 is a block diagram of a method to transmit via a wireless interface system 200 a motion video having Fast Forward 165 presentation characteristics. FIG. 7 is a block diagram of a method to display on a wireless terminal 100 a motion video received having Fast Forward 165 presentation characteristics. In both FIG. 6 and FIG. 7, the Fast Forward display control

command 165 may be substituted with a Fast Rewind display control command 168 without changing the steps of the method.

The invention may be implemented using either a stationary or mobile wireless terminal 100. An example of a mobile wireless terminal may be a mobile wireless telephone 101, as discussed above, whereas an example of a stationary wireless terminal may be a wireless terminal affixed to a residence as a alternative to a landline communication connection. It is understood that any connection within the system may be wired or wireless. Moreover, the invention may be implemented in entirely wired systems in addition to wireless systems. In an entirely wired system, the wired interface between the motion video server 220 and the wired terminal may be any data network connection, such as an internet, an intranet, or an ethernet, using any connection means, such as coaxial cables, telephone landlines, fiber optic cables, or power lines.

A number of embodiments of the present invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. For example, changes in the presentation characteristics of the motion video may or may not be accompanied by a change in the bit rate of digitized video information transmitted from the base station 232 to the wireless phone 101. Accordingly, other embodiments are within the scope of the following claims.

It is also understood that receiving, displaying and transmitting digital data requires appropriate digital processors and memory storage devices to store, buffer and process the data. Appropriate software is also necessary to program the electronic devices to function as intended. Moreover, operation on a cellular telephony network requires wireless phone validation, synchronization, and power control methods and devices, among other commonly known aspects of cellular telephony art. Implementations may use any wireless interface format capable of supporting the data transmissions. For instance, a wireless interface format may be a standard such as CDMA, TDMA, GSM, GSM++, HSCSD, GPRS, UMTS, xDSL, or POTS. Implementations may also use any motion video compression format, including H.261, H.263, MPEG-1, MPEG-2, and MPEG-4.

The invention may be implemented in digital electronic circuitry, or in computer hardware, firmware, software, or in combinations of them. Apparatus of the invention may be implemented in a computer program product tangibly embodied in a machine-readable storage

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